3D

Information

Professional Services Committee

Proposal to Establish a Single Subject Teaching Authorization in Foundational-Level General Science

Executive Summary: This agenda item provides additional information requested by the Commission at the April 2008 Commission meeting regarding a proposal for a new Single Subject authorization in Foundational-Level General Science.

Recommended Action: For information only

Presenter: Teri Clark, Administrator, Professional Services Division

Strategic Plan Goal: 1

Promote educational excellence through the preparation and certification of professional educators

- Sustain high quality standards for the preparation and performance of professional educators and for the accreditation of credential programs

Proposal to Establish a Single Subject Teaching Authorization in Foundational-Level General Science

Introduction

This agenda item furthers the discussion begun at the December 2007 Commission meeting (http://www.ctc.ca.gov/commission/agendas/2007-12/2007-12-3H.pdf) and continued at the April 2008 Commission meeting (http://www.ctc.ca.gov/commission/agendas/2008-04/2008-04-2H.pdf) regarding a proposal for an additional subject area science authorization: Foundational-Level General Science. A Foundational-Level General Science authorization has the potential to increase the number of individuals with an authorization to teach science at the K-8 level and, thus, reduce the number of individuals on waivers, teaching permits and local teaching assignment options. The Foundational-Level General Science authorization would be a limited authorization authorizing the holder to teach general, introductory, and integrated science (integrated science through grade 8 only).

Background

In California, preparing a teacher involves three separate phases: subject matter preparation, preliminary preparation, and induction into the profession. An individual must meet the prerequisite subject matter requirement prior to student teaching and earning the preliminary teaching credential. For candidates pursuing the single subject teaching credentials, there are usually two routes available to satisfy the subject matter requirement: an approved subject matter program and an approved examination. No matter which route is selected by an individual to satisfy the subject matter requirement, the individual must also complete the preliminary preparation program.

Since 1995, the Single Subject credential for K-12 science has been divided into four major areas: Biological Science, Chemistry, Geosciences, and Physics. Each of these content areas has a specific science authorization that an individual may earn. Within each area of science, the appropriate science credential allows an individual to teach introductory science across all four areas, integrated science grades 7-12 and departmentalized classes in the specified area at the high school level. For example, with a Science: Biological Science credential, the individual may teach general science, departmentalized Biology, introductory science in grades K-12, and integrated science in grades 7-12. Integrated science is a method of organizing science courses in life and physical science in an integrated manner rather than as separate content area courses. At the high school level, the typical sequence of science content is one year of Biology, followed by a year of Chemistry, followed by a year of Physics. An integrated science curriculum allows those three content areas to be taught over 1, 2, or 3 years in an integrated manner. High school integrated courses can be on the CSU/UC approved courses list. For more information on the classes authorized by the science credentials, see Table 4 on page 10.

To satisfy the subject matter requirement for the science credential in Biological Science, Chemistry, Geosciences, or Physics, an individual may choose to complete an approved subject matter program or pass the three required California Subject Examination for Teachers (CSET) subtests. For all four areas of science, an individual must pass the two General Science subtests of the CSET in addition to the area-specific subtest. One of the general science subtests addresses Astronomy, Dynamic Processes of the Earth, Earth Resources, Waves, Forces and Motion, Electricity and Magnetism (Subtest 118). The second general subtest addresses Ecology, Genetics and Evolution, Molecular Biology and Biochemistry, Cell and Organismal Biology, Heat Transfer and Thermodynamics, and Structure and Properties of Matter (Subtest 119).

At the April 2008 meeting, the Commission indicated interest in exploring an approved program option for an individual to satisfy science content knowledge for the Foundational-Level General Science authorization in addition to the examination option. Therefore, Table 1, below, has been amended from the version in the April agenda item to show that a individual would have an option to complete an approved subject matter program or pass the two CSET examination subtests.

Table 1: Subject Matter and Pedagogical Requirements for a Foundational-Level General Science Authorization

Individual	**Individual**		
Requirement	**does not hold a Teaching Credential**	**holds a Multiple Subject Credential**	**holds a Single Subject Credential**
Subject Matter	Pass CSET Subtests 118 & 119 **OR** Complete an approved Foundational-Level General Science subject matter program	Pass CSET Subtests 118 & 119 **OR** Complete an approved Foundational-Level General Science subject matter program	Pass CSET Subtests 118 & 119 **OR** Complete an approved Foundational-Level General Science subject matter program
Pedagogy	Complete a teacher preparation program	One course in single subject pedagogy	-

Teachers who are credentialed via this route and who teach courses within this authorization would be considered "Highly Qualified" for the purpose of No Child Left Behind as they would have been required to demonstrate subject matter competence through passage of an examination or completion of an approved program. For an individual who already holds a credential, this authorization would allow the individual to add an authorization and be considered "Highly Qualified" in an additional subject area. In addition to the multiple and single subject credentialed individuals, an individual with an Education Specialist credential could complete an approved Foundational-Level General Science subject matter program or pass the two subtests and earn an additional subject area authorization.

At the December meeting, the Commission posed a number of questions about science credentials, science courses offered in the public schools and the usefulness of a Foundational-Level General Science authorization. The April agenda item presented additional information

related to the teaching of science and science credentials to assist the Commission's discussion of an additional science authorization. This information is summarized below:

Information presented during the April 2008 Commission meeting related to a Foundational-Level General Science Authorization

- The Foundational-Level Math credential allowed about 50% more individuals to earn an authorization to teach mathematics in 2006-07.
- Currently there are 341 individuals who have passed both General Science subtests but have not passed one of the concentration examinations. These individuals would theoretically be eligible for a Foundational-Level General Science authorization.
- Of the 80,000 science courses taught in the public schools in 2006-07, over 43,000 courses were at the foundational level and an individual with a Foundational-Level General Science authorization would be prepared to teach these courses.
- The California Department of Education reports over 15,000 FTE individuals were teaching science in 2006-07 and about 8,000 of them were teaching general science courses.
- Local Teaching Assignment Options were requested for 1,456 teachers to teach science during 2003-07. An additional 467 individuals were reported as being in a misassignment because they were teaching general science without an authorization during these same years.
- In 2006-07, Provisional Internship Permits (PIPs) were issued to 211 individuals to teach Science.
- In 2006-07, Short Term Staffing Permits (STSPs) were issued to 221 individuals to teach Science.

At the April meeting, the Commission and stakeholders made a number of suggestions and asked a number of questions related to the possibility of developing a Foundational-Level General Science authorization:

- What do the original Science Subject Matter Advisory Panel members think of the proposal for a Foundational-Level General Science authorization?
- What does the California Science Teachers Association (CSTA) think about the proposal for a Foundational-Level General Science authorization?
- What do stakeholders (including science teachers, employers, individuals who prepare science teachers and professional developers of science teachers) think about the concept of a General Science authorization including the need for this type of authorization in the public schools and the appropriateness of the authorization and the subject matter requirements being proposed?
- Could Subject Matter Program Standards for a Foundational-Level General Science subject matter program be developed?

This agenda item presents information addressing the questions above related to a possible General Science authorization.

Feedback from the Science Subject Matter Panel

At the April 2008 Commission meeting it was suggested that staff should contact the original science subject matter panel members (Appendix A) and ascertain their opinions on the proposal to develop a Foundational-Level General Science authorization. Staff sent an email to all the

science subject matter advisory panel members with information about the possibility of a new science authorization, links to the two agenda items on this topic, and the draft program standards.

The advisory panel members were then asked the following questions:

1) Are you in support of the idea of a Foundational-Level General Science authorization?
2) Do you believe the two General Science examinations would be a valid assessment of the knowledge and skills needed by a general science teacher?
3) Do you believe the program standards (as described in this agenda item) would be an appropriate course of study to require for the subject matter preparation of a general science teacher?

From the original email and follow-up efforts, staff was able to contact twelve of the seventeen panel members by the agenda deadline. The panel members' feedback varied but there were some common comments across the panel members:

1) Although it would be preferable for individuals to have earned a full science credential, the schools are in desperate need of credentialed science teachers and someone with a General Science authorization would be preferable to an individual on a waiver or permit.
2) The general science Subject Matter Requirements (SMRs) define the content all science teachers should understand.
3) The two general science subtests and the program standards, built on those SMRs, would be a valid assessment and an appropriate course of study for a general science teacher.
4) This authorization could allow teachers with a multiple subjects credential to earn a NCLB compliant credential that allows them to teach science in the middle school.
5) A General Science authorization could be very useful in upper elementary and middle school classrooms.
6) A coursework option would be preferred to an examination option for the satisfaction of the subject matter requirement.
7) This authorization could be an interim document an individual earns while working toward additional authorizations in one or more of the science concentration areas.

Additional efforts will be made to contact the Advisory Panel members who have not responded as of the agenda deadline. If additional feedback is gathered, it will be presented in an in-folder item which would be posted a week prior to the June Commission meeting.

California Science Teachers Association

At the April 2008 Commission meeting it was suggested that staff should contact the professional organization(s) for science teachers and ascertain their opinion on the proposal to develop a Foundational-Level General Science authorization. Staff sent an email to the California Science Teachers Association (CSTA) with information about the possibility of a new science authorization, links to the two agenda items on this topic, and the draft program standards (Appendix B).

The CSTA was then asked the following questions and CSTA provided the following responses:

1) Are you in support of the idea of a Foundational-Level General Science authorization?

Yes. We believe that the General Science credential will fill a need. Because of the need for middle school teachers to be highly qualified in the area they teach, this credential does give a teacher the opportunity to earn a credential which gives them the qualifications to teach the various content areas of science required for grades 6 - 8. We are questioning whether, as a general science only is allowed, does CTC mean general science in grade levels K - 8? We are also assuming that it is understood that the "general science" credential emphasizes the same subjects as specified in the 6-8 standards (i.e., grade 8 emphasizes physical science, grade 7 emphasizes life science and grade 6 emphasizes earth science).

2) Do you believe the two General Science examinations (http://www.cset.nesinc.com/CS_SMR_opener.asp) would be a valid assessment of the knowledge and skills needed by a general science teacher?

The two exams do appear to adequately cover both content and methodology and encompass a variety of the content areas which are covered in the science standards for K - 9. We are also particularly pleased to see that inquiry is included, along with some technology and diversity issues. We assume that people taking this exam do, indeed, have either a general subject credential or another single subject credential so that they have had methodology courses.

3) Do you believe the program standards, as described above, would be an appropriate course of study to require for the subject matter preparation of a general science teacher?

Yes.

Stakeholder Feedback

Staff developed a short, web-based survey to gather stakeholder feedback on the concept of a Foundational-Level General Science authorization. The survey (Appendix C) was designed to gather information from current science teachers, those who prepare science teachers, those who employ science teachers, and those who provide professional development for science teachers. The introduction to the survey summarized the issue and provided information so that interested parties could access the Commission agenda items. The survey was available beginning on April 23 and closed on May 20, 2008. Due to the deadlines for the printed Commission agenda for the June meeting, the stakeholder feedback will be presented in an agenda insert posted the week prior to the June 2008 Commission meeting.

Possible Program Standards for a Foundational-Level General Science Subject Matter Program

Based on Commission discussion at the April 2008 meeting, this agenda item presents draft Foundational-Level General Science Subject Matter Program Standards (Appendix B). These standards are the adopted science subject matter program standards with the deletion of the subject specific standard language for the four concentrations.

Subject Matter Standards Development: In 2001 the Commission appointed four subject matter panels (English, mathematics, science, and social science) to begin the first of three phases to

meet the SB 2042 mandate for single subject matter programs. The single subject matter panels spent considerable time ensuring that the new subject matter standards were grounded in, and aligned with the academic content standards for California K-12 students.

The Science panel developed the Subject Matter Requirements (SMRs) for the four science subject matter programs based on the adopted K-12 Content Standards (adopted October 1998). The SMRs are the subject-specific knowledge, skills, and abilities which specify the content required in Commission-approved subject matter preparation programs for teacher candidates. The SMRs (http://www.ctc.ca.gov/educator-prep/standards/SSMP-Handbook-Science.pdf) were approved by the Commission at a meeting in June 2002. The titles of the science SMRs are displayed below in Table 2, the full text of the general science SMRs is provided in Appendix B, beginning on page 23 of this agenda item.

- The first section of the science SMRs are the General Science SMRs that all approved science subject matter programs must meet. These 12 domains cover the range of life, earth and physical science at an introductory level and are provided on pages 23-31 of this agenda item.
- The second section of the SMRs is the concentration specific SMRs for each of the four concentrations: ***Biology/Life Science, Chemistry, Earth and Planetary Science, and Physics***. These SMRs are not presented in this agenda item since they address the four concentrations, not general science. These four sets of concentration SMRs address the same topics as the 12 domains in the General Science SMRs, but the depth of content is increased in the subject specific concentrations. The content of the concentration SMRs address the content from the California Science Framework as defined for high school courses in Biology, Chemistry, Physics, and Earth Science. Each approved science subject matter program must meet the aligned section of the SMRs, e.g., the Chemistry programs must meet the Chemistry SMRs.
- Part II of the SMRs addresses the skills and abilities that all science teachers must have: Investigation and Experimentation, Nature of Science, and Science and Society. All approved science subject matter programs must meet this section of the SMRs. Part II of the SMRs is presented on pages 31-35 of this agenda item.

Table 2: Science Subject Matter Requirements (SMRs)

Subject Matter Requirements for Prospective Teachers of General Science

Domain 1: Astronomy
Domain 2: Dynamic Processes of the Earth
Domain 3: Earth Resources
Domain 4: Ecology
Domain 5: Genetics and Evolution
Domain 6: Molecular Biology and Biochemistry
Domain 7: Cell and Organismal Biology
Domain 8: Waves
Domain 9: Forces and Motions
Domain 10: Electricity and Magnetism
Domain 11: Heat Transfer and Thermodynamics
Domain 12: Structure and Properties of Matter

Specific Concentration Subject Matter Requirements (SMRs)

Biology/Life Science SMRs
Domain 1: Cell Biology and Physiology
Domain 2: Genetics
Domain 3: Evolution
Domain 4: Ecology

Earth and Planetary Science SMRs
Domain 1: Earth's Place in the Universe
Domain 2: Planet Earth
Domain 3: Energy in the Earth System
Domain 4: Biogeochemical Cycles
Domain 5: California Geology

Chemistry SMRs
Domain 1: Atomic and Molecular Structure
Domain 2: Chemical Reactions
Domain 3: Kinetic Molecular Theory
Domain 4: Solution Chemistry
Domain 5: Chemical Thermodynamics
Domain 6: Organic Chemistry and Biochemistry
Domain 7: Nuclear Processes

Physics SMRs
Domain1: Motion and Forces
Domain 2: Conservation of Energy and Momentum
Domain 3: Heat and Thermodynamics
Domain 4: Waves
Domain 5: Electromagnetism
Domain 6: Quantum Mechanics and the Standard Model of Particles

Part II: Subject Matter Skills and Abilities Applicable to the Content Domains in Science
Domain 1: Investigation and Experimentation
Domain 2: Nature of Science
Domain 3: Science and Society

The panel then developed the Science Subject Matter Program Standards—three other panels were working at the same time to develop the English, mathematics, and social science subject matter standards. The standards were sent out for a field review in August 2002 and adopted by the Commission at the December 2002 meeting. The titles of the standards are provided in Table 3 and the full text of the standards is included in Appendix B, beginning on page 13 of this agenda item.

- The standards in Category I are common to all the single subject matter programs—all sixteen content areas. These standards address issues of programmatic capacity, early field

experience, literacy, technology, diversity and equity, and how the program will assess its candidates.

- The standards in Category II address the specific programmatic requirements that all science subject matter programs must meet: Biology, Chemistry, Earth Science and Physics. The specific scientific content that must be addressed by approved science programs is specified in Program Standards 14 and 15.
    - ***Program Standard 14: Breadth of Study in Science***, is aligned to the SMRs covered in the 12 domains of the Subject Matter Requirements for Prospective Teachers of General Science. Currently all science subject matter programs, no matter if the program is Biology, Chemistry, Earth Science, or Physics, must provide content that addresses the breadth of Program Standard 14.
    - ***Standard 15: Depth of Study in a Concentration Area***, is a four part standard and each approved science subject matter program addresses one of the concentrations. Standard 15 is not provided in this agenda item since it addresses the concentration specific areas but can be found in the full subject matter standards on the Commission's website: http://www.ctc.ca.gov/educator-prep/standards/SSMP-Handbook-Science.pdf .
        Standard 15A: Depth of Study in Biological Sciences
        Standard 15B: Depth of Study in Chemistry
        Standard 15C: Depth of Study in Geosciences (Earth and Planetary Sciences)
        Standard 15D: Depth of Study in Physics

Table 3: Science Subject Matter Program Standards

Category I: Standards Common to All Subject Matter Programs	**Category II: Program Standards for Science**
Standard 1: Program Philosophy and Purpose	Standard 11: The Vision for Science
Standard 2: Diversity and Equity	Standard 12: General Academic Quality
Standard 3: Technology	Standard 13: Integrated Study of Science
Standard 4: Literacy	Standard 14: Breadth of Study in Science
Standard 5: Varied Teaching Strategies	Standard 15: Depth of Study in Science
Standard 6: Early Field Experiences	15A: Biological Science
Standard 7: Assessment of Subject Matter Competence	15B: Chemistry
Standard 8: Advisement and Support	15C: Geosciences
Standard 9: Program Review and Evaluation	15D: Physics
	Standard 16: Laboratory and Field Experiences
	Standard 17: Safety Procedures

As part of the development and approval process, the SMRs and draft standards were field tested in August–October 2002 and adopted by the Commission in December 2002. The SMRs and subject matter preparation program standards address what content a science teacher must know and are based on the adopted K-12 Content Standards. The field review found that the SMRs and program standards, with some minor revisions, defined the content all science teachers should know, the general science SMRs, and the advanced content for the four concentration areas.

Utilizing the work completed in 2002, an approved subject matter program in Foundational-Level General Science would be required to address all the currently adopted science subject matter standards except ***Program Standard 15: Depth of Study in Science.*** If the Commission supports a program route for individuals to satisfy the subject matter requirement for a General Science authorization, staff could return with an action item in the future asking the Commission to adopt the standards for a Foundational-Level General Science approved subject matter program.

Next Steps

If the Commission supports the concept of a Foundational-Level General Science authorization - both an examination route and a program route, the staff would bring an action item to the Commission with proposed subject matter program standards for the Foundational-Level General Science authorization and move forward with the examination route. This would pave the way for a programmatic route for individuals to satisfy the subject matter requirement for this authorization. If the Commission does not support the concept, staff will not bring additional agenda items on this topic.

A separate agenda item is scheduled for this Commission meeting with draft Title 5 regulation language. If the Commission is in support of the proposed regulation language, the Certification Assignment and Waivers Division will move forward with the regulation process to establish a Foundational-Level General Science authorization.

Table 4: Current Single Subject Science Teaching Credentials and Authorized Classes

(service in grades preschool, K - 12, and adults)

Authorized Classes → Type of Credential ↓	Biological Science	Chemistry	Physics	Earth/ Geosciences	Integrated Science	Intro/General Science	Intro Life Science	Intro Physical Science
Science: Biological Science	X				7-12	X	X	X
Science: Chemistry		X			7-12	X	X	X
Science: Physics			X		7-12	X	X	X
Science: Geoscience				X	7-12	X	X	X
Biological Sci (Specialized)	X							
Chemistry (Specialized)		X						
Physics (Specialized)			X					
Geoscience (Specialized)				X				

Table 5: Proposed Foundational-Level General Science Single Subject Teaching Credential and Authorized Classes

(service in grades preschool, K - 12, and adults)

Authorized Classes → Type of Credential ↓	Biological Science	Chemistry	Physics	Earth/ Geosciences	Integrated Science	Intro/General Science	Intro Life Science	Intro Physical Science
General Science (Foundational)					Through Grade 8	X	X	X

Appendix A

Science Subject Matter Advisory Panel

Science Subject Matter Advisory Panel

Panel Member	Position	Institution/School District (2003)
Priscilla Beckman*	Teacher of Science	Glendale Unified School District
George Brimhall	Professor of Science	University of California, Berkeley
Joel Colbert*	Assistant Dean	California State University, Dominguez Hills
Chuck Downing*	Professor of Science	Point Loma Nazarene University
Kathryn Fliegler*	Teacher of Science	Trabuco Hills High School
Maria Lopez-Freeman*	Executive Director	University of California, Los Angeles
Roland Otto	Director of Science Education	Lawrence Livermore Laboratories
Melanie Pearlman	Teacher of Science	Santa Barbara School District
William Pence*	Teacher of Science	San Ramon Valley School District
Richard Sanchez*	Teacher of Science	Holtville Unified School District
Deborah Schurr*	Science Department Chair	Chaffey Joint Union High School District
Jodye Selco*	Professor of Science	University of Redlands
Paul Stanley	Science Department Chair	California Lutheran University
Terie Storar*	Teacher of Science	Greenfield Union School District
Ellen Vasta	Science Curriculum Specialist	Elk Grove Unified School District
Gabriele Wienhausen*	Provost	University of California, San Diego
Susan Zwiep*	Teacher of Science	Montebello Unified School District

* Prior to the agenda cut-off date, these Advisory Panel members provided feedback on the proposal to create a Foundational-Level General Science credential. Additional efforts were made to contact the remaining panel members and any additional feedback will be presented in the in-folder item posted the week prior to the June Commission meeting.

Appendix B

Proposed
Science Subject Matter Program Standards

Standards of Program Quality and Effectiveness

Category I: Standards Common to All Single Subject Matter Preparation Programs

Standard 1: Program Philosophy and Purpose

The subject matter preparation program is based on an explicit statement of program philosophy that expresses its purpose, design, and desired outcomes in relation to the Standards of Quality and Effectiveness for Single Subject Teaching Credential Programs. The program provides the coursework and field experiences necessary to teach the specified subject to all of California's diverse public school population. Subject matter preparation in the program for prospective teachers is academically rigorous and intellectually stimulating. The program curriculum reflects and builds on the State-adopted *Academic Content Standards for K-12 Students* and *Curriculum Frameworks for California Public Schools.* The program is designed to establish a strong foundation in and understanding of subject matter knowledge for prospective teachers that provides a basis for continued development during each teacher's professional career. The sponsoring institution assigns high priority to and appropriately supports the program as an essential part of its mission.

Required Elements

1.1 The program philosophy, design, and intended outcomes are consistent with the content of the State-adopted Academic Content Standards for K-12 students and Curriculum Frameworks for California public schools.

1.2 The statement of program philosophy shows a clear understanding of the preparation that prospective teachers need in order to be effective in delivering academic content to all students in California schools.

1.3 The program provides prospective teachers with the opportunity to learn and apply significant ideas, structures, methods and core concepts in the specified subject discipline(s) that underlies the 6-12 curriculum.

1.4 The program prepares prospective single-subject teachers to analyze complex discipline-based issues; synthesize information from multiple sources and perspectives; communicate skillfully in oral and written forms; and use appropriate technologies.

1.5 Program outcomes are defined clearly and assessments of prospective teachers and program reviews are appropriately aligned.

1.6 The institution conducts periodic review of the program philosophy, goals, design, and outcomes consistent with the following: campus program assessment timelines, procedures, and policies; ongoing research and thinking in the discipline; nationally accepted content standards and recommendations; and the changing needs of public schools in California.

Standard 2: Diversity and Equity

The subject matter program provides equitable opportunities to learn for all prospective teachers by utilizing instructional, advisement and curricular practices that insure equal access to program academic content and knowledge of career options. Included in the program are the essential understandings, knowledge and appreciation of the perspectives and contributions by and about diverse groups in the discipline.

Required Elements:

2.1 In accordance with the Education Code Chapter 587, Statutes of 1999, (See Appendix A), human differences and similarities to be examined in the program include, but are not limited to those of sex, race, ethnicity, socio-economic status, religion, sexual orientation, and exceptionality. The program may also include study of other human similarities and differences.

2.2 The institution recruits and provides information and advice to men and women prospective teachers from diverse backgrounds on requirements for admission to and completion of subject matter programs.

2.3 The curriculum in the Subject Matter Program reflects the perspectives and contributions of diverse groups from a variety of cultures to the disciplines of study.

2.4 In the subject matter program, classroom practices and instructional materials are designed to provide equitable access to the academic content of the program to prospective teachers from all backgrounds.

2.5 The subject matter program incorporates a wide variety of pedagogical and instructional approaches to academic learning suitable to a diverse population of prospective teachers. Instructional practices and materials used in the program support equitable access for all prospective teachers and take into account current knowledge of cognition and human learning theory.

Standard 3: Technology

The study and application of current and emerging technologies, with a focus on those used in K-12 schools, for gathering, analyzing, managing, processing, and presenting information is an integral component of each prospective teacher's program study. Prospective teachers are introduced to legal, ethical, and social issues related to technology. The program prepares prospective teachers to meet the current technology requirements for admission to an approved California professional teacher preparation program.

Required Elements:

3.1 The institution provides prospective teachers in the subject matter program access to a wide array of current technology resources. The program faculty selects these technologies on the basis of their effective and appropriate uses in the disciplines of the subject matter program

3.2 Prospective teachers demonstrate information processing competency, including but not limited to the use of appropriate technologies and tools for research, problem solving, data acquisition and analysis, communications, and presentation.

3.3 In the program, prospective teachers use current and emerging technologies relevant to the disciplines of study to enhance their subject matter knowledge and understanding.

Standard 4: Literacy

The program of subject matter preparation for prospective Single Subject teachers develops skills in literacy and academic discourse in the academic disciplines of study. Coursework and field experiences in the program include reflective and analytic instructional activities that specifically address the use of language, content and discourse to extend meaning and knowledge about ideas and experiences in the fields or discipline of the subject matter.

Required Elements:

4.1 The program develops prospective teachers' abilities to use academic language, content, and disciplinary thinking in purposeful ways to analyze, synthesize and evaluate experiences and enhance understanding in the discipline.

4.2 The program prepares prospective teachers to understand and use appropriately academic and technical terminology and the research conventions of the disciplines of the subject matter.

4.3 The program provides prospective teachers with opportunities to learn and demonstrate competence in reading, writing, listening, speaking, communicating and reasoning in their fields or discipline of the subject matter.

Standard 5: Varied Teaching Strategies

In the program, prospective Single Subject teachers participate in a variety of learning experiences that model effective curriculum practices, instructional strategies and assessments that prospective teachers will be expected to use in their own classrooms.

Required Elements:

5.1 Program faculty include in their instruction a variety of curriculum design, classroom organizational strategies, activities, materials, and field experiences incorporating observing, recording, analyzing and interpreting content as appropriate to the discipline.

5.2 Program faculty employ a variety of interactive engaging teaching styles that develop and reinforce skills and concepts through open-ended activities such as direct instruction, discourse, demonstrations, individual and cooperative learning explorations, peer instruction, and student-centered discussion.

5.3 Faculty development programs provide tangible support for subject matter faculty to explore and use exemplary and innovative curriculum practices.

5.4 Program faculty use varied and innovative teaching strategies, which provide opportunities for prospective teachers to learn how content is conceived and organized

for instruction in a way that fosters conceptual understanding as well as procedural knowledge.

5.5 Program coursework and fieldwork include the examination and use of various kinds of technology that are appropriate to the subject matter discipline.

Standard 6: Early Field Experiences

The program provides prospective Single Subject teachers with planned, structured field experiences in departmentalized classrooms beginning as early as possible in the subject matter program. These classroom experiences are linked to program coursework and give a breadth of experiences across grade levels and with diverse populations. The early field experience program is planned collaboratively by subject matter faculty, teacher education faculty and representatives from school districts. The institution cooperates with school districts in selecting schools and classrooms for introductory classroom experiences. The program includes a clear process for documenting each prospective teacher's observations and experiences.

Required Elements:

6.1 Introductory experiences shall include one or more of the following activities: planned observations, instruction or tutoring experiences, and other school based observations or activities that are appropriate for undergraduate students in a subject matter preparation program.

6.2 Prospective teachers' early field experiences are substantively linked to the content of coursework in the program.

6.3 Fieldwork experiences for all prospective teachers include significant interactions with K-12 students from diverse populations represented in California public schools and cooperation with at least one carefully selected teacher certificated in the discipline of study.

6.4 Prospective teachers will have opportunities to reflect on and analyze their early field experiences in relation to course content. These opportunities may include field experience journals, portfolios, and discussions in the subject matter courses, among others.

6.5 Each prospective teacher is primarily responsible for documenting early field experiences. Documentation is reviewed as part of the program requirements.

Standard 7: Assessment of Subject Matter Competence

The program uses formative and summative multiple measures to assess the subject matter competence of each candidate. The scope and content of each candidate's assessment is consistent with the content of the subject matter requirements of the program and with institutional standards for program completion.

Required Elements:

7.1 Assessment within the program includes multiple measures such as student performances, presentations, research projects, portfolios, field experience journals, observations, and interviews as well as oral and written examinations based on criteria established by the institution.

7.2 The scope and content of each assessment is congruent with the specifications for the subject matter knowledge and competence as indicated in the content domains of the Commission-adopted subject matter requirement.

7.3 End-of-program summative assessment of subject matter competence includes a defined process that incorporates multiple measures for evaluation of performance.

7.4 Assessment scope, process, and criteria are clearly delineated and made available to students when they begin the program.

7.5 Program faculty regularly evaluate the quality, fairness, and effectiveness of the assessment process, including its consistency with program requirements.

7.6 The institution that sponsors the program determines, establishes and implements a standard of minimum scholarship (such as overall GPA, minimum course grade or other assessments) of program completion for prospective single subject teachers.

Standard 8: Advisement and Support

The subject matter program includes a system for identifying, advising and retaining prospective Single Subject teachers. This system will comprehensively address the distinct needs and interests of a range of prospective teachers, including resident prospective students, early deciders entering blended programs, groups underrepresented among current teachers, prospective teachers who transfer to the institution, and prospective teachers in career transition

Required Elements:

8.1 The institution will develop and implement processes for identifying prospective Single Subject teachers and advising them about all program requirements and career options.

8.2 Advisement services will provide prospective teachers with information about their academic progress, including transfer agreements and alternative paths to a teaching credential, and describe the specific qualifications needed for each type of credential, including the teaching assignments it authorizes.

8.3 The subject matter program facilitates the transfer of prospective teachers between post-secondary institutions, including community colleges, through effective outreach and advising and the articulation of courses and requirements. The program sponsor works cooperatively with community colleges to ensure that subject matter coursework at feeder campuses is aligned with the relevant portions of the *State-adopted Academic Content Standards for K-12 Students in California Public Schools*.

8.4 The institution establishes clear and reasonable criteria and allocates sufficient time and personnel resources to enable qualified personnel to evaluate prospective teachers' previous coursework and/or fieldwork for meeting subject matter requirements.

Standard 9: Program Review and Evaluation
The institution implements a comprehensive, ongoing system for periodic review of and improvement to the subject matter program. The ongoing system of review and improvement involves university faculty, community college faculty, student candidates and appropriate public schools personnel involved in beginning teacher preparation and induction. Periodic reviews shall be conducted at intervals not exceeding 5 years.

Required Elements:

9.1 Each periodic review includes an examination of program goals, design, curriculum, requirements, student success, technology uses, advising services, assessment procedures and program outcomes for prospective teachers.

9.2 Each program review examines the quality and effectiveness of collaborative partnerships with secondary schools and community colleges.

9.3 The program uses appropriate methods to collect data to assess the subject matter program's strengths, weaknesses and areas that need improvement. Participants in the review include faculty members, current students, recent graduates, education faculty, employers, and appropriate community college and public school personnel.

9.4 Program improvements are based on the results of periodic reviews, the inclusion and implications of new knowledge about the subject(s) of study, the identified needs of program students and school districts in the region, and curriculum policies of the State of California.

Standard 10: Coordination
One or more faculty responsible for program planning, implementation and review coordinate the Single Subject Matter Preparation Program. The program sponsor allocates resources to support effective coordination and implementation of all aspects of the program. The coordinator(s) foster and facilitate ongoing collaboration among academic program faculty, local school personnel, local community colleges and the professional education faculty.

Required Elements:

10.1 A program coordinator will be designated from among the academic program faculty.

10.2 The program coordinator provides opportunities for collaboration by faculty, students, and appropriate public school personnel in the design and development of and revisions to the program, and communicates program goals to the campus community, other academic partners, school districts and the public.

10.3 The institution allocates sufficient time and resources for faculty coordination and staff support for development, implementation and revision of all aspects of the program.

10.4 The program provides opportunities for collaboration on curriculum development among program faculty.

10.5 University and program faculty cooperate with community colleges to coordinate courses and articulate course requirements for prospective teachers to facilitate transfer to a baccalaureate degree-granting institution.

Category II: Program Standards for Science

Standard 11: The Vision for Science
The institution articulates a philosophical vision of science and the education of prospective science teachers. Each program references the current Science Framework for California Public Schools: Kindergarten Through Grade Twelve (2002) as part of its vision statement.

Required Elements

11.1 The program includes a code of ethics that can be applied to the practice of science.

11.2 The program examines ethical, moral, social, and cultural implications of significant issues and ideas in science and technology.

11.3 The program explores practical solutions to challenging important and relevant problems.

Standard 12: General Academic Quality
The program is academically rigorous and intellectually stimulating. It provides opportunities for students to experience and practice analyzing complex situations to make informed decisions and to participate in scientific problem solving. In the program, each prospective teacher develops effective written and oral communication skills with a focus on concepts and methodologies that comprise academic discourse in science.

Required Elements

12.1 The program requires sufficient practice in written and oral communication skills that enable prospective teachers to express scientific ideas, concepts, and methods accurately.

12.2 The program promotes the use of quantitative reasoning and encourages prospective teachers to analyze complex situations, make informed decisions, and participate in scientific problem solving.

12.3 The program regularly requires prospective teachers to participate in scientific investigations.

12.4 The program allows prospective teachers to gain experience in critically analyzing and reviewing scientific writings and research.

12.5 The program provides opportunities for prospective teachers to examine conceptual and physical models and their evolution over time.

Standard 13: Integrated Study of Science
The program reflects science as an integrated entity and examines interrelationships among the disciplines, and variations in the structures, content, and methods of inquiry in the disciplines are studied. Each prospective single subject teacher gains an understanding of how the conceptual foundations of the scientific disciplines are related to each other.

Required Elements

13.1 Each integrative study component develops the prospective single subject teacher's understanding of how the conceptual foundations of the scientific disciplines are related to each other.

13.2 Each integrative study component provides opportunities for prospective teachers to examine the interconnections between different fields of science.

13.3 The integrative study component(s) of the program require that prospective teacher use higher-level thinking skills while involved in coursework and research in each science discipline.

13.4 Faculty teaching in the program and prospective teachers in various disciplines of science meet regularly to exchange ideas and perspectives.

13.5 The program includes courses and/or projects that integrate science as a whole.

Standard 14: Breadth of Study in Science
The science program is organized to provide prospective teachers a sufficiently broad understanding of science so that, as future literate science teachers, they have the necessary knowledge, skills, and abilities to develop scientific literacy among their students. A breadth of study provides familiarity with the nature of science and major ideas foundational to all the sciences and provides a basis for prospective teachers to engage in further studies of a scientific discipline. The program is aligned with the Science Content Standards for California Public Schools: Kindergarten Through Grade Twelve (1998).

Required Elements

14.1 The program encompasses the general science specifications for subject matter knowledge and competence on pages 21 through 31, which includes the following general areas of study aligned with the K-12 student academic content standards.

14.2 The program addresses the subject matter skills and abilities applicable to the content domains in science listed below:

- A- Astronomy
- B- Dynamic Processes of the Earth (Geodynamics)
- C- Earth Resources
- D- Ecology
- E- Genetics/Evolution
- F- Molecular Biology and Biochemistry
- G- Cell and Organismal Biology
- H- Waves
- I- Forces and Motion

J- Electricity and Magnetism
K- Heat Transfer and Thermodynamics
L- Structure and Properties of Matter

Standard 16: Laboratory and Field Experiences
Laboratory and field experiences constitute a significant portion of coursework in a program that includes open-ended, problem solving experiences. Prospective teachers have the opportunity to design a variety of laboratory experiments. Data are collected, analyzed, and processed using statistical analysis and current technology (where appropriate).

Required Elements

16.1 The program includes required laboratory components in no less than one-third of its courses.

16.2 The program includes periodic open-ended, problem solving experiences in its coursework.

16.3 The program requires prospective teachers to organize, interpret, and communicate observation data collected during laboratory or field experiences using statistical analysis when appropriate.

16.4 The program requires prospective teachers to design and evaluate laboratory experiments and/or fieldwork.

16.5 The program involves prospective teachers in research and collection of data that requires utilization of current technology.

Standard 17: Safety Procedures
The program instructs prospective teachers in proper safety procedures prior to laboratory and field experiences. This includes instruction in emergency procedures and proper storage, handling and disposal of chemicals and equipment. The program provides facilities equipped with necessary safety devices and appropriate storage areas. When the program provides experiences with live organisms, they are observed, captured, and cared for both ethically and lawfully.

Required Elements

17.1 The program instructs prospective teachers in proper safety procedures (safe uses of chemicals, specimens, and specialty equipment) prior to laboratory and field experiences, and implements current safety guidelines and regulations.

17.2 The program provides facilities that are equipped with appropriate safety devices.

17.3 The program provides instruction in, and demonstrates emergency procedures and proper storage, handling, and disposal of chemicals, specimen, and equipment.

Part I: Content Domains for Subject Matter Understanding and Skill in General Science

Domain 1. Astronomy

Candidates demonstrate an understanding of the foundations of the astronomy contained in the Science Content Standards for California Public Schools: Kindergarten Through Grade Twelve (1998) as outlined in the Science Framework for California Public Schools: Kindergarten Through Grade Twelve (2002) from an advanced standpoint. To ensure a rigorous view of astronomy and its underlying structures, candidates have a deep conceptual knowledge of the subject matter. Candidates understand that knowledge of the structure and composition of the universe can be learned from studying stars and galaxies and their evolution. They recognize that objects in the sky move in regular and predictable patterns. Candidates explain how and why the moon's appearance changes during the four-week lunar cycle. They understand how telescopes magnify the appearance of distant objects in the sky, including the moon and the planets. They realize that the solar system consists of planets and other bodies that orbit the sun in predictable paths.

1.1 Astronomy

a. Describe the chemical composition and physical structure of the universe

b. Describe the structure of the solar system and its place in the Milky Way galaxy

c. Distinguish between stars and planets

d. Recognize that stars vary in color, size, and luminosity

e. Describe a simple model of how fusion in stars produces heavier elements and results in the production of energy, including light

f. Describe the regular and predictable patterns of stars and planets in time and location

g. Explain and predict changes in the moon's appearance (phases)

h. Describe the use of astronomical instruments in collecting data, and use astronomical units and light years to describe distances

(Science Content Standards for California Public Schools, Grades 3:4a-e; Grade 5: 5a-c; Grade 6: 7a; Grade 7: 6d, 7a; Grade 8:4a-e; Grades 9-12, Earth Sciences: 1a, 1e, 1g, 2a, 2c, 2e-f)

Domain 2. Dynamic Processes of the Earth (Geodynamics)

Candidates demonstrate an understanding of the foundations of the geodynamics contained in the Science Content Standards for California Public Schools: Kindergarten Through Grade Twelve (1998) as outlined in the Science Framework for California Public Schools: Kindergarten Through Grade Twelve (2002) from an advanced standpoint. To ensure a rigorous view of geodynamics and its underlying structures, candidates have a deep conceptual knowledge of the subject matter. Candidates understand that Earth's features can be explained by a variety of dynamic processes that have occurred in the past and continue to occur. They understand that plate tectonics account for most of the important features of Earth's surface and major geologic events. Candidates explain how surficial processes and agents such as waves, wind, water, and

ice are slowly modifying Earth's land surface. They understand how weathering, transport, and deposition of sediment are related to this reshaping. Candidates are familiar with evidence from rocks that allows us to understand geologic history and the evolution of life on Earth. They can use observed properties of rocks and minerals to determine their processes of formation. Candidates understand that most of the energy on the Earth comes from the sun. They know that energy from the sun heats Earth unevenly, causing air movements that result in changing weather patterns. They use their understanding of heat to explain the many phenomena on Earth's surface that are affected by the transfer of energy through radiation and convection.

2.1 Tectonic Processes and Features

a. Diagram the features that provide evidence for plate tectonics
b. Summarize the thermal processes driving plate movement
c. Explain how density and buoyancy are related to plate tectonics
d. Describe types of plate boundaries
e. Relate the causes of volcanoes, earthquakes, and earth resources to tectonic processes
f. Summarize earthquake processes in terms of epicenter, focal mechanism, distance, and materials, and the role various factors play in the amount of damage caused by an earthquake

(Science Content Standards for California Public Schools, Grade 6: 1a-g; Grade 8: 4a-e; Grades 9-12, Earth Sciences: 1e, 1g, 2c, 3b, 3d)

2.2 Rock Formation

a. Diagram and explain the rock cycle
b. Describe relative and absolute dating techniques, including how half-lives are used in radiometric dating

(Science Content Standards for California Public Schools, Grade 4: 4a; Grade 7: 3c, 4a–e; Grades 9-12, Chemistry: 11f)

2.3 Shaping Earth's Surface: Surficial Processes and Features

a. Describe the dynamic processes of erosion, deposition, and transport
b. Describe coastal processes including beach erosion and natural hazards
c. Describe the effects of natural hazards, including earthquakes, volcanic eruptions, landslides, and floods, on natural and human-made habitats and environmental and human responses to those events

(Science Content Standards for California Public Schools, Grade 4: 5c; Grade 6: 1e, 1f, 2a–d)

2.4 Energy in the Earth System

a. Diagram the water cycle and describe interrelationships of surface and sub-surface reservoirs
b. Explain daily and seasonal changes in the sky (i.e., the sun's position and the intensity and duration of sunlight)
c. Analyze the uneven heating of Earth by the sun

d. Discuss the effects of air movements on weather
e. Describe the energy transfer processes of convection, conduction, and radiation in relation to the atmosphere/ocean and Earth's interior structure
f. Interpret weather maps to predict weather patterns

(Science Content Standards for California Public Schools, Grade 3: 4e; Grade 5: 3a-d, 4a-e; Grade 6: 4a-e; Grades 9-12, Earth Sciences: 5a-b)

Domain 3. Earth Resources

Candidates demonstrate an understanding of the Earth resources contained in the Science Content Standards for California Public Schools: Kindergarten Through Grade Twelve (1998) as outlined in the Science Framework for California Public Schools: Kindergarten Through Grade Twelve (2002) from an advanced standpoint. To ensure a rigorous view of Earth resources and their underlying structures, candidates have a deep conceptual knowledge of the subject matter. Candidates know there are many different natural energy and material resources, including air, soil, rocks, minerals, petroleum, fresh water, wildlife, and forests, and know how to classify them as renewable or nonrenewable. They realize that sources of energy and materials differ in amounts, distribution, usefulness, and the time required for their formation. Candidates understand that the utility of energy sources is determined by factors that are involved in converting these sources to useful forms and the consequences of the conversion process. They know the natural origin of the materials used to make common objects.

3.1 Earth Resources

a. Describe a variety of energy resources, including fossil fuels, nuclear fuels, solar, and biomass
b. Recognize earth materials as resources (e.g., rocks, minerals, soils, and water)
c. Identify resources as renewable vs. nonrenewable
d. Compare extraction and recycling in relation to energy, cost, and demand
e. Explain sustainable uses of resources with respect to utility, cost, human population, and environmental consequences

(Science Content Standards for California Public Schools, Grade 2: 3e; Grade 6: 6a-c; Grades 9-12, Earth Sciences: 9a, 9c)

Domain 4. Ecology

Candidates demonstrate an understanding of the foundations of the ecology contained in the Science Content Standards for California Public Schools: Kindergarten Through Grade Twelve (1998) as outlined in the Science Framework for California Public Schools: Kindergarten Through Grade Twelve (2002) from an advanced standpoint. To ensure a rigorous view of ecology and its underlying structures, candidates have a deep conceptual knowledge of the subject matter. Candidates understand how organisms in ecosystems exchange energy and nutrients among themselves and with the environment. They can identify factors that affect organisms within an ecosystem, including natural hazards and human activity.

4.1 Ecology

a. Explain energy flow and nutrient cycling through ecosystems (e.g., food chain, food web)

b. Explain matter transfer (e.g., biogeochemical cycles) in ecosystems

c. Distinguish between abiotic and biotic factors in an ecosystem

d. Compare the roles of photosynthesis and respiration in an ecosystem

e. Describe interrelationships within and among ecosystems (e.g., predator/prey)

f. Identify and explain factors that affect population types and size (e.g., competition for resources, niche, habitats, species and population interactions, abiotic factors)

(Science Content Standards for California Public Schools, Grade 4: 2a-c, 3a-c; Grade 5: 2f-g; Grade 6: 5a-e)

Domain 5. Genetics and Evolution

Candidates demonstrate an understanding of the foundations of the genetics and evolution contained in the Science Content Standards for California Public Schools Science Content Standards for California Public Schools: Kindergarten Through Grade Twelve (1998) as outlined in the Science Framework for California Public Schools: Kindergarten Through Grade Twelve (2002) from an advanced standpoint. To ensure a rigorous view of genetics and evolution and their underlying structures, candidates have a deep conceptual knowledge of the subject matter. Candidates understand that a typical cell of any organism contains genetic instructions that specify its traits. They can explain how biological evolution accounts for the diversity of species that developed through gradual processes over many generations. Candidates can describe evidence used to explain the evolution of life on Earth.

5.1 Genetics and Evolution

a. Explain the inheritance of traits which are determined by one or more genes, including dominance, recessiveness, sex linkage, phenotypes, genotypes, and incomplete dominance
b. Solve problems that illustrate monohybrid and dihybrid crosses
c. Compare sexual and asexual reproduction
d. Explain how the coding of DNA (deoxyribonucleic acid) controls the expression of traits by genes
e. Define mutations and explain their causes
f. Explain the process of DNA replication
g. Describe evidence, past and present, that supports the theory of evolution, including diagramming relationships that demonstrate shared characteristics of fossil and living organisms
h. Explain the theory of natural selection, including adaptation, speciation, and extinction
i. List major events that affected the evolution of life on Earth (e.g., climate changes, asteroid impacts)

(Science Content Standards for California Public Schools, Grade 7: 2a-e, 3a-e; Grades 9-12, Biology/Life Sciences: 4c, 7c, 8a)

Domain 6. Molecular Biology and Biochemistry

Candidates demonstrate an understanding of the foundations of the molecular biology and biochemistry contained in the Science Content Standards for California Public Schools Kindergarten Through Grade Twelve (1998) (1998) as outlined in the Science Framework for

California Public Schools: Kindergarten Through Grade Twelve (2002) from an advanced standpoint. To ensure a rigorous view of molecular biology and biochemistry and their underlying structures, candidates have a deep conceptual knowledge of the subject matter. Candidates understand and apply the principles of chemistry that underlie the functioning of biological systems. They describe the properties of biochemical compounds that make them essential to life.

6.1 Biology and Biochemistry

a. Demonstrate understanding that a small subset of elements (C, H, O, N, P, S) makes up most of the chemical compounds in living organisms by combining in many ways
b. Recognize and differentiate the structure and function of molecules in living organisms, including carbohydrates, lipids, proteins, and nucleic acids
c. Describe the process of protein synthesis, including transcription and translation
d. Compare anaerobic and aerobic respiration
e. Describe the process of photosynthesis

(Science Content Standards for California Public Schools, Grade 5: 2f-g; Grade 6: 5a; Grade 8: 6b-c; Grades 9-12, Biology/Life Sciences: 1d, 1f, 1g, 1h, 4a, Chemistry: 10c)

Domain 7. Cell and Organismal Biology

Candidates demonstrate an understanding of the foundations of the cell and organismal biology contained in the Science Content Standards for California Public Schools Kindergarten Through Grade Twelve (1998) as outlined in the Science Framework for California Public Schools: Kindergarten Through Grade Twelve (2002) from an advanced standpoint. To ensure a rigorous view of cell and organismal biology and their underlying structures, candidates have a deep conceptual knowledge of the subject matter. Candidates understand that all living organisms are composed of cells and explain important cellular processes. They describe and give examples of how the anatomy and physiology of plants and animals illustrate the complementary nature of structure and function. Candidates demonstrate understanding of physical principles that underlie biological structures and functions. They apply these principles to important biological systems.

7.1 Cell and Organismal Biology

a. Describe organelles and explain their function in the cell
b. Relate the structure of organelles and cells to their functions
c. Identify and contrast animal and plant cells
d. Explain the conversion, flow, and storage of energy of the cell
e. Identify the function and explain the importance of mitosis and meiosis as processes of cellular and organismal reproduction
f. Compare single-celled and multicellular organisms, noting the role of cell differentiation in the development of multicellular organisms
g. Describe the levels of organization (e.g., cells, tissues, organs, systems, organisms) in plants and animals
h. Describe the structures and functions of human body systems, including, but not limited to, the skeletal, reproductive, nervous, and circulatory systems
i. Explain the major structures and their functions in vascular and nonvascular plants

j. Describe the life processes of various plant groups, including, but not limited to, reproduction, photosynthesis, respiration, and transpiration
k. Explain the reproductive processes in flowering plants

(Science Content Standards for California Public Schools, Grade 3: 1b, 1c; Grade 5: 2a, 2e; Grade 7: 1a-f, 5a-g, 6d, 6h-j)

Domain 8. Waves

Candidates demonstrate an understanding of the foundations of waves as contained in the Science Content Standards for California Public Schools Kindergarten Through Grade Twelve (1998) and outlined in the Science Framework for California Public Schools: Kindergarten Through Grade Twelve (2002) from an advanced standpoint. To ensure a rigorous view of waves and their underlying structures, candidates have a deep conceptual knowledge of the subject matter. Candidates understand that all waves have a common set of characteristic properties. They apply their knowledge of these properties to describe and predict the behavior of waves, including light waves, sound waves, and seismic waves. Candidates apply the simple principles of optics to explain how various lenses work.

8.1 Waves

a. Compare the characteristics of sound, light, and seismic waves (e.g., transverse/longitudinal, travel through various media, relative speed)
b. Explain that energy is transferred by waves without mass transfer and provide examples
c. Explain how lenses are used in simple optical systems, including the camera, telescope, microscope, and the eye
d. Explain and apply the laws of reflection and refraction
e. Compare transmission, reflection, and absorption of light in matter

(Science Content Standards for California Public Schools, Grade 3: 1d, 2a-d, 4c; Grade 6: 3a; Grade 7: 6a, 6c-g; Grades 9-12, Physics: 4a-b, 4d, 4f)

Domain 9. Forces and Motion

Candidates demonstrate an understanding of the foundations of forces and motion as contained in the Science Content Standards for California Public Schools Kindergarten Through Grade Twelve (1998) and outlined in the Science Framework for California Public Schools: Kindergarten Through Grade Twelve (2002) from an advanced standpoint. To ensure a rigorous view of forces and motion and their underlying structures, candidates have a deep conceptual knowledge of the subject matter. Candidates describe the motion of an object and understand the relationships among its velocity, speed, distance, time, and acceleration. They understand the relationship among force, mass, and acceleration. Candidates use Newton's laws to predict the motion of objects.

9.1 **Forces and Motion**

a. Discuss and apply Newton's laws (i.e., first, second, third, and law of universal gravitation)
b. Define pressure and relate it to fluid flow and buoyancy (e.g., heart valves, atmospheric pressure)

c. Describe the relationships among position, distance, displacement, speed, velocity, acceleration, and time, and perform simple calculations using these variables for both linear and circular motion
d. Identify the separate forces that act on a body (e.g., gravity, pressure, tension/compression, normal force, friction) and describe the net force on the body
e. Construct and analyze simple vector and graphical representations of motion and forces (e.g., distance, speed, time)
f. Identify fundamental forces, including gravity, nuclear forces, and electromagnetic forces (magnetic and electric), and explain their roles in nature, such as the role of gravity in maintaining the structure of the universe
g. Explain and calculate mechanical advantages for levers, pulleys, and inclined planes

(Science Content Standards for California Public Schools, Grade 7: 6h-j; Grade 8: 1a-f, 2a-g)

Domain 10. Electricity and Magnetism

Candidates demonstrate an understanding of the foundations of the electricity and magnetism contained in the Science Content Standards for California Public Schools: Kindergarten Through Grade Twelve (1998) as outlined in the Science Framework for California Public Schools: Kindergarten Through Grade Twelve (2002) from an advanced standpoint. To ensure a rigorous view of electricity and magnetism and their underlying structures, candidates have a deep conceptual knowledge of the subject matter. Candidates understand that electric and magnetic phenomena are related. They use knowledge of electricity and magnetism to explain many practical applications.

10.1 Electricity and Magnetism

a. Describe and provide examples of electrostatic and magnetostatic phenomena
b. Predict charges or poles based on attraction/repulsion observations
c. Build a simple compass and use it to determine direction of magnetic fields, including the Earth's magnetic field
d. Relate electric currents to magnetic fields and describe the application of these relationships, such as in electromagnets, electric current generators, motors, and transformers
e. Design and interpret simple series and parallel circuits
f. Define and calculate power, voltage differences, current, and resistance in simple circuits

(Science Content Standards for California Public Schools, Grade 4: 1a-g; Grade 9-12, Physics: 5a-c)

Domain 11. Heat Transfer and Thermodynamics

Candidates demonstrate an understanding of the foundations of heat transfer and thermodynamics as contained in the Science Content Standards for California Public Schools: Kindergarten Through Grade Twelve (1998) and outlined in the Science Framework for California Public Schools: Kindergarten Through Grade Twelve (2002) from an advanced standpoint. To ensure a rigorous view of heat transfer and thermodynamics and their underlying structures, candidates have a deep conceptual knowledge of the subject matter. Candidates explain how heat flows in a predictable manner. They understand that energy cannot be created or destroyed, although in many processes energy is transferred to the environment as heat.

Candidates apply their knowledge to explain how many phenomena on Earth's surface are affected by the transfer of energy through radiation and convection currents.

11.1 Heat Transfer and Thermodynamics

a. Know the principle of conservation of energy and apply it to energy transfers
b. Discuss how the transfer of energy as heat is related to changes in temperature
c. Diagram the direction of heat flow in a system
d. Describe the methods of heat transfer by conduction, convection, and radiation, and provide examples for each
e. Explain how chemical energy in fuel is transformed to heat
f. Design and explain experiments to induce a physical change such as freezing, melting, or boiling
g. Distinguish between physical and chemical changes and provide examples of each

(Science Content Standards for California Public Schools, Grade 6: 3a-d, 4d; Grade 8: 3b, 3d-e, 5c-d; Grade 9-12, Physics: 3a-c, Chemistry: 7a-c)

Domain 12. Structure and Properties of Matter

Candidates demonstrate an understanding of the structure and properties of matter contained in the Science Content Standards for California Public Schools: Kindergarten Through Grade Twelve (1998) as outlined in the Science Framework for California Public Schools: Kindergarten Through Grade Twelve (2002) from an advanced standpoint. To ensure a rigorous view of matter and its underlying structures, candidates have a deep conceptual knowledge of the content area. Candidates know that more than 100 elements of matter exist, each with distinct properties and a distinct atomic structure. They describe both macroscopic and microscopic properties of matter including intermolecular and intramolecular forces. They know that the organization of the periodic table is based on the properties of the elements and reflects the structure of atoms. Candidates understand how the periodic table is constructed and the periodic trends in chemical and physical properties that can be seen in the table. They recognize chemical reactions as processes that involve the rearrangement of electrons to break and form bonds with different atomic partners. Candidates demonstrate understanding of the principles of chemistry that underlie the functioning of biological systems.

12.1 Structure and Properties of Matter

a. Identify, describe, and diagram the basic components within an atom (i.e., proton, neutron, and electron)
b. Know that isotopes of any element have different numbers of neutrons but the same number of protons, and that some isotopes are radioactive
c. Differentiate between atoms, molecules, elements, and compounds
d. Compare and contrast states of matter and describe the role energy plays in the conversion from one state to another
e. Discuss the physical properties of matter including structure, melting point, boiling point, hardness, density, and conductivity
f. Recognize that all chemical substances are characterized by a unique set of physical properties
g. Define and calculate density, and predict whether an object will sink or float in a fluid

h. Explain that chemical changes in materials result in the formation of a new substance corresponding to the rearrangement of the atoms in molecules
i. Explain and apply principles of conservation of matter to chemical reactions, including balancing chemical equations
j. Distinguish among acidic, basic, and neutral solutions by their observable properties
k. Describe the construction and organization of the periodic table
l. Based on position in the periodic table, predict which elements have characteristics of metals, semi-metals, non-metals, and inert gases
m. Explain chemical reactivity using position on the periodic table
n. Predict and explain chemical bonding using elements' positions in the periodic table
o. Recognize that inorganic and organic compounds (e.g., water, salt, carbohydrates, lipids, proteins, nucleic acids) are essential to processes within living systems
p. Explain the central role of carbon in living system chemistry

(Science Content Standards for California Public Schools, Grade 8: 3a-c, 5a-e, 6a, 6c, 7a-c, 8a-d; Grades 9-12, Chemistry: 7b, 11c)

Part II: Subject Matter Skills and Abilities Applicable to the Content Domains in Science

Domain 1. Investigation and Experimentation

Candidates for Single Subject Teaching Credentials in Science formulate and conduct scientific investigations. They select appropriate scientific tools, make relevant measurements of changes in natural phenomena, and present unbiased findings in logical and meaningful formats using charts, maps, tables, models, graphs, and labeled diagrams. Candidates apply mathematics to scientific investigations and experimentation(s) for the purpose of quantifying results and drawing conclusions. Candidates interpret experimental results and determine whether further information is necessary to formulate accurate conclusions. They communicate results through various methods, and use technology where appropriate.

1.1 Question Formulation

a. Formulate and evaluate a viable hypothesis
b. Recognize the value and role of observation prior to question formulation
c. Recognize the iterative nature of questioning
d. Given an experimental design, identify possible hypotheses that it may test

(Science Content Standards for California Public Schools, Grade 6: 7a)

1.2 Planning a Scientific Investigation (including Experimental Design)

a. Given a hypothesis, formulate an investigation or experimental design to test that hypothesis
b. Evaluate an experimental design for its suitability to test a given hypothesis
c. Distinguish between variable and controlled parameters

(Science Content Standards for California Public Schools, Grade 5: 6c-d; Grade 8: 9a, 9c)

1.3 Observation and Data Collection

a. Identify changes in natural phenomena over time without manipulating the phenomena (e.g., a tree limb, a grove of trees, a stream, a hill slope)

b. Analyze the locations, sequences, and time intervals that are characteristic of natural phenomena (e.g., locations of planets over time, succession of species in an ecosystem)
c. Select and use appropriate tools and technology (e.g., computer-linked probes, spreadsheets, graphing calculators) to perform tests, collect data, analyze relationships, and display data
d. Evaluate the precision, accuracy, and reproducibility of data
e. Identify and analyze possible reasons for inconsistent results, such as sources of error or uncontrolled conditions
f. Identify and communicate sources of unavoidable experimental error
g. Recognize the issues of statistical variability and explain the need for controlled tests
h. Know and evaluate the safety issues when designing an experiment and implement appropriate solutions to safety problems
i. Appropriately employ a variety of print and electronic resources (e.g., the World Wide Web) to collect information and evidence as part of a research project
j. Assess the accuracy validity and reliability of information gathered from a variety of sources

(Science Content Standards for California Public Schools, Grade 3: 5a; Grade 6: 7a-b, 7g-h; Grade 7: 7a-b; Grade 8: 9b; Grades 9-12, Investigation and Experimentation: 1a-c, 1i-j, 1m)

1.4 Data Analysis/Graphing

a. Construct appropriate graphs from data and develop qualitative and quantitative statements about relationships between variables
b. Recognize the slope of the linear graph as the constant in the relationship y=kx and apply this principle in interpreting graphs constructed from data
c. Apply simple mathematical relationships to determine a missing quantity in an algebraic expression, given the two remaining terms (e.g., speed = distance/time, density = mass/volume, force = pressure x area, volume = area x height)
d. Determine whether a relationship on a given graph is linear or non-linear and determine the appropriateness of extrapolating the data
e. Solve scientific problems by using quadratic equations and simple trigonometric, exponential, and logarithmic functions

(Science Content Standards for California Public Schools, Grade 6: 7c; Grade 8: 9d-g; Grades 9-12, Investigation and Experimentation: 1e)

1.5 Drawing Conclusions and Communicating Explanations

a. Draw appropriate and logical conclusions from data
b. Communicate the logical connection among hypotheses, science concepts, tests conducted, data collected, and conclusions drawn from the scientific evidence
c. Communicate the steps and results of an investigation in written reports and oral presentations
d. Recognize whether evidence is consistent with a proposed explanation
e. Construct appropriate visual representations of scientific phenomenon and processes (e.g., motion of Earth's plates, cell structure)

f. Read topographic and geologic maps for evidence provided on the maps and construct and interpret a simple scale map

(Science Content Standards for California Public Schools, Grade 5: 6g; Grade 6: 7e-f; Grade 7: 7c-e; Grade 8: 9a; Grades 9-12, Investigation and Experimentation: 1d, 1h)

Domain 2. Nature of Science

Candidates recognize that science is an active endeavor in which acquisition of knowledge is based upon the collection and examination of data. Candidates understand that scientists have a responsibility to report fully and openly the methods and results of their observations and experiments, even if those results disagree with their favored hypotheses or are controversial in public opinion. They understand that to hide data, arbitrarily eliminate data, or conceal how an experiment was conducted is to invite errors, make those errors difficult to discover, and risk harm to colleagues and communities. They understand that scientists carefully consider questions and challenges raised by fellow scientists about the assumptions, procedures, and accuracy of their experiments. They understand that a fundamental aspect of scientific inquiry is that it is dynamic and self-correcting by design. Conclusions, hypotheses, and theories are tested in every experiment and revised or rejected when they no longer correctly or accurately predict experimental results. Candidates understand that scientists must consider the safety, ethical concerns, risks, and costs and benefits of experiments to society.

2.1 Scientific Inquiry

a. Distinguish among the terms hypothesis, theory, and prediction as used in scientific investigations
b. Evaluate the usefulness, limitations, and interdisciplinary and cumulative nature of scientific evidence as it relates to the development of models and theories as representations of reality
c. Recognize that when observations do not agree with an accepted scientific theory, either the observations are mistaken or fraudulent, or the accepted theory is erroneous or incorrect
d. Understand that reproducibility of data is critical to the scientific endeavor
e. Recognize that science is a self-correcting process that eventually identifies misconceptions and experimental biases
h. Recognize that an inquiring mind is at the heart of the scientific method and that doing science involves thinking critically about the evidence presented, the usefulness of models, and the limitations of theories
i. Recognize that theories are judged by how well they explain observations and predict results and that when they represent new ideas that are counter to mainstream ideas they often encounter vigorous criticism
j. Recognize that when observations, data, or experimental results do not agree, the unexpected results are not necessarily mistakes; to discard the unusual in order to reach the expected is to guarantee that nothing but what is expected will ever be seen
k. Know why curiosity, honesty, openness, and skepticism are so highly regarded in science and how they are incorporated into the way science is carried out

(Science Content Standards for California Public Schools, Grade 6: 7e; Grades 9-12, Investigation and Experimentation: 1f-g, 1n)

2.2 Scientific Ethics

a. Understand that honesty is at the core of scientific ethics; first and foremost is the honest and accurate reporting of procedures used and data collected
b. Know that all scientists are obligated to evaluate the safety of an investigation and ensure the safety of those performing the experiment
c. Know the procedures for respectful treatment of all living organisms in experimentation and other investigations

2.3 Historical Perspectives

a. Discuss the cumulative nature of scientific evidence as it relates to the development of models and theories
b. Recognize that as knowledge in science evolves, when observations do not support an accepted scientific theory, the observations are reconsidered to determine if they are mistaken or fraudulent, or if the accepted theory is erroneous or incomplete (e.g., an erroneous theory is the Piltdown Man fossil; an incomplete theory is Newton's laws of gravity)
c. Recognize and provide specific examples that scientific advances sometimes result in profound paradigm shifts in scientific theories
d. Discuss the need for clear and understandable communication of scientific endeavors so that they may be reproduced and why reproduction of these endeavors is important

(Science Content Standards for California Public Schools, Grade 6: 7d; Grade 7: 7c, 7e; Grades 9-12, Investigation and Experimentation: 1k, 1n)

Domain 3. Science and Society

Candidates understand that science relies on basic human qualities such as reasoning, insight, curiosity, skill, and creativity – as well as on scientific habits of mind such as intellectual honesty, tolerance of ambiguity, skepticism, and openness to new ideas. Candidates recognize their responsibility to increase scientific literacy so that the general population can understand current issues and appreciate their personal roles and responsibilities. Candidates know about possible hazards and take precautions that are the basis for creating a safe learning environment that benefits all students. They are familiar with established rules and guidelines that intend to ensure the safety of students and to protect the subjects and environments studied. Candidates understand that technology is the application of proven scientific knowledge for practical purposes serving human needs; however, science and technology are interrelated—one often propels the other.

3.1 Science Literacy

a. Recognize that science attempts to make sense of how the natural and the designed world function
b. Demonstrate the ability to apply critical and independent thinking to weigh alternative explanations of events
c. Apply evidence, numbers, patterns, and logical arguments to solve problems

d. Understand that, although much has been learned about the objects, events and phenomena in nature, there are many unanswered questions, i.e., science is a work in progress
e. Know that the ability of science and technology to resolve societal problems depends on the scientific literacy of a society

3.2 Diversity

a. Identify examples of women and men of various social and ethnic backgrounds with diverse interests, talents, qualities and motivations who are, or who have been, engaged in activities of science and related fields

3.3 Science, Technology, and Society

a. Identify and evaluate the impact of scientific advances on society
b. Recognize that scientific advances may challenge individuals to reevaluate their personal beliefs

(Science Content Standards for California Public Schools, Grades 9-12, Investigation and Experimentation: 1m, 1n)

3.4 Safety

a. Choose appropriate safety equipment for a given activity (e.g., goggles, apron, vented hood)
b. Discuss the safe use, storage, and disposal of commonly used chemicals and biological specimens
c. Assess the safety conditions needed to maintain a science laboratory (e.g., eye wash, shower, fire extinguisher)
d. Read and decode MSDS/OSHA (Material Safety Data Sheet/Occupational Safety and Health Administration) labels on laboratory supplies and equipment
e. Discuss key issues in the disposal of hazardous materials in either the laboratory or the local community
f. Be familiar with standard safety procedures such as those outlined in the Science Safety Handbook for California Schools (1999)

Appendix C

General Science
Stakeholder Survey

Survey responses were gathered from
April 24-May 20, 2008

Science Stakeholder Survey

1. Providing the following information is optional:
   Name
   Email

2. Please identify the role(s) that currently apply to you:
   Science teacher
   Employer of science teachers
   Preparer of science teachers
   Professional developer who works with science teachers
   Other

3. Are you supportive of the creation of a Foundational-Level General Science Credential?
   Yes No Do not have an opinion

4. Comments about a Foundational-Level General Science Credential…

Science Teachers

1. Are you currently a K-12 science teacher? If no, please go to the next page of the survey
   Yes No

2. In what district/COE do you work?

3. What type of district is it?
   K-12 Elementary High School

4. What grade level(s) do you currently teach? (Mark all that apply)
   K 1 2 3 4 5 6 7 8 9 10 11 12

5. What type of science courses do you teach? (Mark all that apply)
   General Science Introductory Science Integrated Science
   Chemistry Biology Physics
   Life Science Physical Science Earth Science

Employers of Science Teachers

1. Are you currently an employer of K-12 science teachers? If no, please go to the next page of the survey
   Yes No

2. What type of local education agency do you represent?
   School District Office County Office of Education

3. Please identify the school/district/COE by name or CDS code

4. What type of school/district/COE is it?
   K-12 Elementary High School

5. How many certificated staff (FTE) are employed to teach science by your school/district/county office?

6. Indicate on what type of credential or authorization your science teachers are serving (Mark all that apply)

- Credential
- Supplementary or Subject Matter Authorization
- Local Teaching Assignment
- Teaching Permit (STST or PIP) or Waiver
- Limited Assignment Permit
- Do not know

7. What is the total number of individuals teaching science on a document that is not compliant with No Child Left Behind Act?

8. How difficult is it to fill your science positions—with individuals that are fully credentialed to teach the science course?

- We have no problem filling all our science positions
- We have trouble occasionally filling a science position
- We regularly have trouble filling one or more science positions
- We have been unable to fill one or more science positions.

9. How many FTE positions are in your school/district/COE where a General Science credential would be appropriate?

Preparer of Science Teachers

1. Are you currently a preparer of K-12 science teachers? If no, please go to the next page of the survey

2. What segment of educator preparation are you affiliated with?

CSU UC Private District/COE Community college

3. Are you affiliated with the department/school college of Teacher Preparation or Letters and Science—subject matter preparation, or both?

Teacher Preparation Subject Matter Preparation Both

4. For a General Science credential, would you support an examination route, a program route, or both for individuals to meet the subject matter requirement?

Examination Subject Matter Program Both

Professional Developer of Science Teachers

1. Are you currently a professional developer of K-12 science teachers? If no, please go to the next page of the survey

Concluding Comments

1. Please provide any additional information related to the proposed General Science credential that you believe would assist the Commission in its decision making.